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HYDRAULIC MOTOR VEHICLE BRAKE SYSTEM WITH ANTILOCK CONTROL DEVICE

[Hydraulische Kraftfahrzeug-Bremsanlage mit Antiblockierregeleinrichtung]

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HYDRAULIC MOTOR VEHICLE BRAKE SYSTEM WITH ANTILOCK CONTROL DEVICE

In a known hydraulic motor vehicle brake system with antilock control device is provided a controllable hydraulic pump, which is connected to the wheel brake cylinders, which assumes the function of the brake servo unit when the antilock control is inactive and the function of a brake pressure modulator when the antilock control is active. Its output pressure is controlled in the first case by the output pressure of the main brake cylinder and in the second case by a control signal transmitted by the antilock control device. In the new hydraulic motor vehicle brake system, a hydraulic pump should also assume the function of the brake servo unit as well as also the function of the pressure modulator; however, the complexity, in particular the technical complexity of the control thereof, should remain comparatively low.

The hydraulic pump, which can be preferably reversible in its conveying direction and is configured as a toothed wheel pump that can be automatically activated if the service brake is actuated, is interposed in turn in the brake line leading from

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[1] Numbers in the margin indicate pagination in the foreign text.

the main brake cylinder to the wheel brake cylinder. To it is connected in parallel a proportional pressure control valve whose low-pressure connection is connected to the hydraulic pump on the side of the main brake cylinder and whose high-pressure connection is connected to the hydraulic pump on the side of the wheel brake cylinder. /2

Description

The invention concerns a hydraulic motor vehicle brake system with antilock control device of the kind mentioned in the preamble of patent claim 1.

Hydraulic motor vehicle brake systems, in which the usual servo units for generating brake pressure that are not mechanically connected to the main brake cylinder or the usual underpressure brake servo units are not used, but which use hydraulic pumps (preferably driven by an electric motor) instead, are known from DE-OS 33 42 552 or 33 42 555.

In this known hydraulic motor vehicle brake system, the hydraulic pressure generated by the main brake cylinder when the service brake is actuated is used as reference input for the hydraulic pump that is connected to the assigned wheel brake cylinders. In this way, on the one hand, the pressure connection between the main brake cylinder and the brake disks is interrupted automatically via an electronic control device if

a minimum predetermined pressure of the main brake cylinder is exceeded and, on the other hand, the output pressure of the hydraulic pump is controlled to a value that is proportional to the output pressure of the main cylinder but higher than the latter. In connection with an antilock control device (DE-OS 33 42 555), instead, the output pressure of the hydraulic pump is controlled in dependence upon a control signal supplied by the antilock control device during the operating phases in which the antilock control device effects an active control.

It is an object of the invention to noticeably reduce the overall complexity, in particular the technical complexity of the control of a hydraulic motor vehicle brake system of the kind mentioned in the preamble of patent claim 1, while ensuring a reliable servo support during normal braking operating phases as well as guaranteeing the usual antilock control functions.

This object was attained with the features of patent claim 1 in accordance with the invention.

Advantageous further developments and embodiments of the invention are disclosed in the dependent claims.

The function of the brake servo unit can be detected during normal operating phases in accordance with the invention during these operating phases via the combination of the hydraulic pump, which can be reversible in its conveying direction, and

the proportional pressure control valve, which is connected in parallel during such operating phases, and the function of a pressure modulator can be realized during such operating phases in which the antilock control device effects an active control.

The invention will be described in the following based on an exemplary embodiment depicted in principle in the drawings.

In the single figure of the drawings is merely shown a cutout of a usual hydraulic dual-circuit brake system, which is necessary for understanding the invention, and in particular only one of the brake line branches leading from the main brake cylinder to one of the wheel brake cylinders. The antilock control device of the brake system is not shown in more detail. It corresponds to a usual antilock control device with reference to the signal detection and signal processing.

According to the invention, in the brake line **5** leading from the main brake cylinder **1** to the assigned wheel brake cylinder **3** is interposed a hydraulic pump **4**, which is configured in the shown exemplary embodiment as a toothed wheel pump.

The hydraulic pump can be reversible in its conveying direction and is automatically activated if the service brake is actuated, that is, when the brake pedal **2** is actuated. The toothed wheel pump is configured preferably as a toothed wheel pump driven by an electric motor, so that its activation and

deactivation can be controlled in the easiest way via the electric brake light switch that is usually provided in a hydraulic brake system.

The hydraulic pump is a known proportional pressure control valve **6** connected in parallel as a bypass. A proportional pressure control valve, known earlier also as a pressure ratio valve, maintains constant automatically the ratio between an input pressure and an output pressure, and in particular independently from the changing input pressure. The pressure ratio is therein inversely proportional to the surface ratio of the face surfaces A_2 or A_1 of a step piston **9** effective in the proportional pressure control valve, which are exposed to the input pressure or the output pressure.

The proportional pressure control valve **6** is arranged in such a way that its first connection **7** that coacts directly with the largest face surface A_2 of the step piston **9** on which the lower pressure is applied in the active control function is connected to the hydraulic pump **4** on the side of the cylinder, and the second connection **8** that coacts directly with the smaller face surface A_1 of the step piston on which the higher pressure is applied in the active control function is connected to the hydraulic pump on the side of the wheel brake cylinder.

In the operating phases in which the antilock control device is not active when the service brake is actuated, the hydraulic pump 4 in combination with the parallel connected proportional pressure control valve 6 takes over the function of the brake servo unit.

If the brake pedal 2 is actuated, pressure is built up, on the one hand, by the main brake cylinder 1 connected downstream, and the hydraulic pump 4 is activated, for example, via a usual brake like switch in the active conveying direction shown with the drawn arrow. The hydraulic pump works moreover initially in short circuit via the opened outlet 10 of the proportional pressure control valve 6, while in all cases a specific dynamic pressure is generated in the wheel brake cylinders 3 connected downstream. At the same time, the step piston 9 is axially displaced under the action of the output pressure P_{HZ} of the main cylinder 1 that builds up, which affects the differential surface A_2-A_1 of the step piston, so that the outlet 10 of the proportional pressure control valve is ultimately closed.

After the short circuit is discontinued, a pressure P_{Servo}, which is controlled by the proportional pressure control valve 6, builds up at the outlet of the hydraulic pump 4 and therewith also in the wheel brake cylinder 3, whose height depends from the surface ratio A_2/A_1 of the proportional pressure control

valve as well as from the output pressure P_{HZ} of the main brake cylinder **1** acting as input pressure. The proportional pressure control valve keeps constant the ratio between its input pressure corresponding to the output pressure P_{HZ} of the main brake cylinder **1** and its output pressure corresponding to the hydraulic pump output pressure P_{Servo} independently from the changing input pressure in the ratio /3

$P_{Servo}/P_{Hz}=A_2/A_1$

The wheel brake cylinders **3** are in this way fed with a controlled servo pressure P_{Servo}, which is increased or can be reduced continuously in correspondence with the actuation of the brake pedal **2**.

A toothed wheel pump is preferably used (as in the exemplary embodiment) as a hydraulic pump **4**. In this way, it is ensured that the basic function of the hydraulic motor vehicle brake system can be maintained also if a pump drive fails, that is, if the function of the brake servo unit fails, because hydraulic fluid can be conveyed via the then freely rotating toothed wheels in the usual way from the main brake cylinder **1** to the wheel brake cylinders **3**.

The hydraulic pump **4** is used for pressure modulation in the operating phases in which the antilock control device effects an

active control when the service brake is actuated. With the pressure requirement "Reduce Pressure," the hydraulic pump **4** is redirected in its conveying direction in the direction of the main brake cylinder via a corresponding control signal of the control electronics (which is not shown in detail) of the antilock brake system, which is indicated in the figure with dashed arrows. Because of the given pressure ratios, the outlet **10** in the proportional pressure control valve **6** is moreover closed by the displacing step piston **9** and hydraulic fluid is conveyed back from the wheel brake cylinders (whose hydraulic pressure drops in correspondence to the control requirements) into the main brake cylinder **1**, and in particular for so long as the control requirement "Reduce Pressure" exists.

As soon as the control requirement "Reduce Pressure" has been discontinued because the danger of a locking of the wheels is no longer present, the hydraulic pump **4** is again activated in its original conveying direction. It is advantageous that the delivery rate of the hydraulic pump **4** can be controlled in a simple manner, for example, by controlling the pump speed. In this way, it is possible in an advantageous manner to influence the characteristic of the pressure reduction that takes place during antilock control, for example, in dependence upon the assigned wheel speed.

In the exemplary embodiment that is shown, the hydraulic pumps/proportional pressure control valve arrangement **4/6** is assigned directly to the one wheel brake cylinder **3**; each one of the other three wheels of a four-wheel motor vehicle can be assigned in a corresponding manner to such an arrangement. Basically, it depends however from the design and type of hydraulic motor vehicle brake system as well as the used antilock control device, if all the wheels are assigned individually or if groups thereof are assigned to such an arrangement.

It is also conceivable to use the hydraulic pump **4** in addition within the frame of a known acceleration slip control (ASR) to brake the affected wheels (without assistance of the vehicle driver) in a corresponding control requirement. For this purpose, the hydraulic pump **4** must be merely activated by the control electronic of the acceleration slip control (conveying direction in the sense of the drawn arrow), on the one hand, and the path over the parallel proportional pressure control valve **6** must be blocked, on the other hand, for example, it can occur with the aid of a magnetic valve connected upstream.

Patent Claims

1. A hydraulic motor vehicle brake system having an antilock control device, a pedal-actuated main brake cylinder, and at least one controllable hydraulic pump connected to assigned wheel brake cylinders, which assumes the function of the brake servo unit when the antilock control is inactive and the function of a brake pressure modulator when the antilock control is active, wherein

the hydraulic pump (4) is interposed in the brake line (5) that leads from the main brake cylinder (1) to the assigned wheel brake cylinder (3),

the hydraulic pump (4) can be redirected in its conveying direction and can be activated automatically by actuating the service brake,

and the hydraulic pump (4) is connected in parallel as bypass to a proportional pressure control pump (6), which is connected to the hydraulic pump (4) with its first connection (7) at which low pressure is applied when the control function is active on the side of the main cylinder, and with its second connection (8) at which a high pressure is applied when the control function is activated on the side of the wheel brake cylinders.

2. The hydraulic motor vehicle brake system of claim 1, wherein the hydraulic pump (4) is configured as a toothed wheel pump, preferably as a toothed wheel pump driven by an electric motor.

3. The hydraulic motor vehicle brake system of claim 1 or 2, wherein the hydraulic pump (4) can be redirected in its conveying direction within the frame of the antilock control during the control requirement "Reduce Pressure" in the direction of the main brake cylinder (1).

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